Highlights

Chesapeake Futures, an effort undertaken by scientists and technical experts under the auspices of the Chesapeake Bay Program's Scientific and Technical Advisory Committee, developed three scenarios for the Bay and its watershed, timed to the year 2030. This exercise focuses on long-term possibilities and long-term choices. The three scenarios are for Recent Trends (essentially the status quo), Current Objectives (accounting for current baywide agreements and commitments),[1] and Feasible Alternatives (innovative technologies and aggressive approaches). While all projections and future outcomes presented in this report should be read in context, with an understanding of specific background and assumptions, the following highlights outline some of the key findings of this effort.

The Purpose of Futures

While resource managers, decision makers, and the rest of us would, of course, love to have clear predictions of the future, the world has rarely proceeded quite as planned. Given the difficulty of prediction, especially with a system as variable as the Chesapeake Bay, what can we expect from Chesapeake Futures?

Chesapeake Futures is not meant to be predictive; rather it sets out a series of three possible scenarios based on choices we make now. To create these scenarios, the experts used Bay computer models, past and current, but they also brought personal experiences, observations, and opinions into play. Consequently, some of the reasoning in the report will track well with the computer models, but some will diverge. The purpose of Chesapeake Futures, then, is not to refine the current attempts to model the Bay, but instead to use what we know—in the broadest sense—to guide both our thinking and our management efforts as we journey forward through the first three decades of the 21st century.

The Chesapeake Bay faces an uncertain future. If sediment and nutrient loads continue at levels witnessed at the end of the 20th century, multiplied by a growing population and new development, water quality will worsen. Water clarity and oxygen levels will slide back toward conditions not seen since the 1980s. Specifically, total loadings of nitrogen to the Bay would grow by about 30 million pounds—about 10 percent over current levels—by 2030 representing the loss of more than half of the load reductions achieved between 1985 and 2000. Total phosphorus loadings would grow by about 3 million pounds, nearly 15 percent, losing one-third of the load reductions achieved within this same time period.

Escalating nutrient and sediment loads would result not only from a population expected to reach about 19 million by the year 2030, but also from poor land use planning, with continued rapid loss of farm and forest lands, and only modest improvements in agricultural methods and wastewater treatment.

These additional loads would largely defeat current efforts to restore underwater grasses, cause further loss of oxygen in the Bay's bottom waters, and undermine efforts to restore oysters due to worsening water quality. Such would be the future, if the trends of the latter decades of the 20th century hold to the year 2030.

Current Efforts

The Bay will fare better if we can fulfill several current commitments, as expressed in ambitious Bay agreements, including *Chesapeake 2000*. Total nitrogen loadings from all sources would decline by 45 million pounds, or about 15 percent of recent levels, by the year 2030. With these achievements, nitrogen loadings would remain slightly lower than the 1987 40-percent goal for reducing "controllable" sources. By meeting current objectives, total loadings of phosphorus would decline by some 4 million pounds or 21 percent of 2000 levels. Reductions in nutrient loadings under this scenario would be even greater, if not for a growing population and predicted land use trends.

Given the success of several current Bay programs, underwater grass beds should roughly double in area with consequent improvements in bottom habitats. On the other hand, shoreline erosion would increase and significant areas of tidal wetlands would be lost; with this erosion comes associated increases in light-blocking sediments.

The Bay's primary productivity would decline somewhat, but higher production by bottom-dwelling algae would cause some alteration of food chains, resulting in modest improvements in habitats and production of important Bay fisheries.

A Brighter Future

With the implementation of numerous alternative strategies and emerging technologies, the future of the Bay looks considerably different. Under a feasible alternatives strategy, the total loadings of nitrogen from all sources would drop by some 143 million pounds, or 47 percent of recent loadings, by 2030. Total phosphorus loadings would drop by 10 million pounds, or 53 percent. Reductions in nutrient and sediment loads, due to highly progressive land development practices, and cutting-edge agricultural and waste treatment methods, would lead to improved water quality in the Bay. The air, too, would be cleaner, with the potential to reduce both mobile and stationary sources of nitrogen oxides by some 70 percent—leading to less atmospheric deposition of nitrogen in the Bay and its watershed.

These changes would ultimately lead to improvements in Bay water quality, with resulting improvements in its food web. Fisheries habitat would recover, especially in the Bay's bottom waters, with positive impacts on bottom-dwelling organisms. These improvements, along with progressive fisheries management, would help sustain fish and shellfish stocks, and bolster the Bay's economic productivity, as well as its ecological health.

Land Use and Development

If recent trends continue. . .

- The area of developed land in the watershed will increase by more than 60 percent by 2030, resulting in the loss of more than two million acres of forests and agricultural land.
- Impervious surface area will increase by more than 25 percent in many sub-watersheds, further degrading the quality of streams throughout the central part of the Chesapeake watershed.
- Nitrogen loads to the Bay due to land development and population growth will increase by about 35 million pounds per year—only slightly offset by a loss of inputs from agricultural lands, estimated at some 5 million pounds of nitrogen per year. Phosphorus loads coming specifically from developed lands would increase by about 1.8 million pounds per year.
- Air quality will deteriorate as vehicle miles driven grow faster than the population, outstripping improvements in auto emissions technology.

If current objectives are met. . .

- Despite policies to preserve open space, new development will cause the loss of about 800,000 acres of forests and agricultural land by 2030.
- The amount of impervious surface will increase significantly, only slightly less than under Recent Trends.
- Though nitrogen loads to the Bay will decrease overall, contributions due to land development and population growth will increase by over 18 million pounds per year (slightly more than half the increase under the Recent Trends scenario).

- Annual phosphorus loads from developed lands will increase by less than 0.7 million pounds.
- Riparian buffer restoration goals will be met or exceeded, resulting in significant improvements in local water quality.
- Modest improvements in air quality will be achieved with tightened auto emissions standards; vehicle miles driven will continue to grow, but at a reduced pace.

If feasible alternatives are put in place . . .

- Creative growth management and strategic land preservation efforts will reduce the development of resource lands in the watershed to about 350,000 acres—about 17 percent of Recent Trends.
- The amount of impervious surface will increase only slightly—a reduction from Recent Trends.
- While overall nitrogen loads to the Bay will decrease, inputs from new development and population growth will increase by about 8 million pounds per year, roughly one-quarter of those projected under the Recent Trends scenario.
- Strategically preserved and restored riparian buffers will further ameliorate nonpoint-source inputs of nutrients resulting from development.
- New and expanded public transportation networks will stabilize or reduce the use of automobiles. Improved emission control technologies, increased fuel efficiency and alternative technologies (e.g., fuel cells) adopted to reduce greenhouse gas emissions will result in significantly improved air quality.
- The use of feasible programs and technologies could reduce nitrogen loading rates from urban areas—both impervious and pervious surfaces—from an estimated 22 pounds per acre given recent trends to an estimated 19 pounds per acre.

Forests

If recent trends continue . . .

- Despite several decades of increasing forest cover driven by reforestation, the amount of forest cover will level off quickly and then decline.
- Further wide-scale loss of forests will continue in or near metropolitan areas.
- The fragmenting of forests will continue throughout the basin, with fragmentation most acute near metropolitan areas and the Coastal Plain and Piedmont provinces.
- A drop-off in agriculture-to-forest conversion is possible, especially in the Ridge and Valley and Appalachian Plateau provinces, with fewer farms to go out of production.
- Riparian forest buffer restoration will produce positive effects locally, but regional gains will remain small as limited progress towards restoration goals is largely offset by losses elsewhere.

If current objectives are met . . .

- A decline in total forest cover within the Coastal Plain and Piedmont will continue, particularly in metropolitan suburbs, with increasing forest cover in other parts of the basin. A net gain in total forest of the Chesapeake Bay basin should result.
- Modest and localized decreases in forest fragmentation will occur, due to better planning of development.
- Gains in riparian buffer mileage will lead to significantly improved local water quality, but only modest decreases in nutrient and sediment inputs to the Bay.
- Despite the positive effects of efforts to preserve resource lands, the links among patches of forest will remain spotty and forest function will improve only slightly beyond the Recent Trends scenario.

If feasible alternatives are put in place . . .

- Forest cover will increase much more significantly as forest cover in the Coastal Plain and Piedmont is stabilized.
- Riparian buffers will increase somewhat, and there will be a decrease in forest fragmentation.
- Highly active management of private forestland and non-consumptive management of public forests lead to increased quality and quantity of forests throughout the watershed.

- Better product development and marketing lead to strengthened economic infrastructure for forest products.
- More sophisticated social attitudes and technical knowledge will aid in the development of a rich forestland base, with local and regional nutrient management planning, and potential long-term management of environmental impacts in the watershed.

Agriculture

If recent trends continue . . .

- Sprawling residential and commercial development will result in the loss of almost 700,000 acres of agricultural land.
- With less farmland available to go out of production, agriculture-to-forest conversion could decline, particularly in the Ridge and Valley and Appalachian Plateau provinces.
- Demand for undeveloped land will raise prices, fragment existing farmland, and alter the character of rural areas.
- Small farmers will find it difficult to make a living from traditional farming as global market trends and other economic forces erode their profits.
- Existing farms will experience a greater dependence on intensive agriculture.
- Technology and globalization will have some positive effects on agriculture.

If current objectives are met . . .

- Land preservation efforts of the *Chesapeake 2000* agreement will preserve open space and guide development patterns; however, 400,000 acres of agricultural land will still be converted to urban and suburban uses.
- Even if farmlands are preserved, agricultural industries will face economic difficulties and a dwindling number of people may be willing to farm for a living.
- The implementation of soil and water conservation plans on croplands and hay fields will reduce nitrogen loadings by 9 percent and phosphorus loadings by 21 percent.
- Nutrient management plans will be successfully applied to half of the tilled cropland and hay fields in the watershed.

If feasible alternatives are put in place . . .

- Land preservation efforts, in combination with programs that target the economic sustainability of farming, will preserve open space and viable rural communities. Fewer than 300,000 acres of agricultural land will be lost to new development.
- Technological advances and policies will resolve animal waste problems, improve efficiency, and provide financial planning and business management aid to farmers.
- Various economic and environmental policies along with behavioral changes could further ensure the existence and success of agriculture in the watershed.

Chesapeake Bay and its Fisheries

If recent trends continue…

- In addition to continued contributions from agricultural and legacy sediment, additional sediment will enter the Bay from rapid land development, bypassing of the Susquehanna dams, and erosion of the shoreline due to accelerated sea level rise. Coupled with the stimulation of plankton growth from increased nutrient loading, water clarity in much of the Bay will decrease.
- Significant areas of tidal wetlands—their landward migration restricted—will be lost to sea level rise.
- As average nitrogen loadings creep back toward 1985 levels due to population growth and development, excessive phytoplankton production will continue. Anoxia and severe hypoxia will be an annual occurrence, worse in high-discharge years.
- Loadings of toxic contaminants will decline slowly, but seafood consumption advisories will continue due to a legacy of contaminants.
- Submerged aquatic vegetation will contract, except in those tributaries remote from increased sources of sediment and nutrients.

If current objectives are met . . .

- More limited land development, improved stormwater management and riparian buffer restoration will hold the line for sediment inputs from the watershed, but sediments mobilized from shoreline erosion will increase.
- Water clarity in some regions of the Bay and its tidal tributaries will increase due to decreased nutrient loadings, but not in areas near rapidly eroding shorelines.
- Significant areas of tidal wetlands will ultimately succumb to sea level rise and restrictions to their landward migration.
- Average nitrogen loadings will decline, eventually resulting in demonstrable reductions of excessive phytoplankton growth and severe hypoxia, equivalent to levels of the mid-1970s. Except in the driest years, some anoxia will still occur.
- Loadings of contaminants will decline a bit more rapidly than under Recent Trends, but impairments due to legacy contamination will continue.
- Submerged aquatic vegetation will expand in selected tributaries, approximately doubling in extent through the Bay.
- Benthic microalgae will play a greater role in the Bay's biological productivity, while bacteria and small phytoplankton will contribute less. Production of fish relying on these bottom resources will increase as food chain efficiency increases and preferred habitats expand.
- The biological diversity and resiliency of the Bay ecosystem will increase, buffering the Bay from extreme events and reducing the frequency and severity of algal blooms.
- The socioeconomic value of the Bay's fisheries will increase modestly as the productive capacity of the Bay ecosystem increases and harvests are managed more sustainably.

If feasible alternatives are put in place…

Well-managed growth and development, substantial retrofitting of stormwater infrastructure, and removal of sediment behind Susquehanna dams will result in real reductions in sediment loads from rivers. Adaptive shoreline management strategies will help sustain tidal wetlands.

- Water clarity in most regions of the Bay will increase substantially due to decreased nutrient loadings.
- The total acreage of tidal wetlands will be maintained close to present levels by preventing barriers to their landward migration and through active management to enhance soil accretion in deteriorating marshes.
- Average nitrogen loadings will decline to nearly one-half of those experienced toward the end of the 20th century, approaching levels not seen since the 1950s. This decline will result in approximately proportional reductions in plankton productivity and substantial reductions in the extent of hypoxia, again back to levels typical of the 1950s. Significant anoxia will occur only during flood years.
- Practical applications of a zero-discharge ethic in industry, government, and society in general will lead to dramatically reduced loadings of many contaminants. Nevertheless, localized toxic effects will occur despite our best efforts to manage inputs of legacy contaminants and contaminated sediments, as well as our continuing reliance on herbicides in agriculture.
- Submerged aquatic vegetation beds will expand in extent some four- or five-fold.
- Primary production will decrease by one-third, but production of many fish and crabs will actually increase due to greater food efficiency.
- The Bay's useful production, diversity, and resilience will improve even more, approximating conditions characteristic of the 1950s.
- The living resources of the Chesapeake will provide more sustained and profitable benefits to society from the improved health of the Bay.

Endnotes

[1]Current Objectives include many of the concrete objectives in a series of Bay agreements, including *Chesapeake 2000*. This scenario is not, however, identical to those agreements, since much of their language is essentially goal oriented (such as "a toxics-free Bay") and not easily quantifiable for use in this exercise.